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Examination of Racial Differences in Management of Cardiovascular Disease

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Objectives. **We sought to identify the clinical characteristics associated with, and to investigate the impact of cohort selection criteria on, interracial use of invasive cardiac procedures and to determine survival.**

Background. **Although interracial differences in the use of invasive cardiac procedures have been previously reported, the underlying reasons are not known.**

Methods. **A retrospective cohort study was conducted at a Veterans Affairs Medical Center. Study patients were evaluated for cardiovascular disease between January 1 and December 31, 1993.**

Results. **The study included 1,406 male patients (85% white, 58% married), with a mean age of 63.4 years. African Americans were less likely than whites to undergo procedures (cardiac catheterization: odds ratio [OR] 0.37, 95% confidence interval [CI] 0.24 to 0.58; coronary angioplasty: OR 0.60, 95% CI 0.25 to 1.49; coronary bypass surgery: OR 0.22, 95% CI 0.08 to 0.63; any procedure: OR 0.32, 95% CI 0.21 to 0.50). On bivariate analysis, patients who underwent cardiac procedures were more likely to be younger, married and reside nonlocally and less likely to have severe comorbid disease; however, African Americans were less likely to be married and to reside nonlocally and more likely to have severe comorbid disease. Cohorts adjusting for referral status and specified cardiac diagnoses reduced or reversed interracial treatment differences. Thirty-day and 1-year survival rates (96% and 87.6%, respectively) were equivalent.**

Conclusions. **Racial disparity in invasive cardiac procedure use may be partially explained by clinical differences and cohort selection bias. Despite treatment differences, survival rates were equivalent in African Americans and whites.**

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Despite significant advances in diagnostic and therapeutic interventions during the past two decades, ischemic heart disease (IHD) continues to be the leading cause of mortality in the United States (1). Use of invasive cardiac procedures for evaluating and managing this disease has been shown to improve patient outcomes (2); however, these technologies have not been used uniformly among all ethnic populations. Several investigators using administrative data bases, within and outside the Department of Veterans Affairs (DVA), have observed consistent and dramatic racial differences in the utilization of invasive procedures for the evaluation and treatment of cardiovascular disease (CVD) (3–12). Specifically, cardiac catheterization (CC), percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft surgery (CABG) appear to be performed less often in African Americans than in whites. However, these studies' reliance on administrative data bases precludes a complete understanding of the reasons for observed racial differences. Importantly, these administrative data bases have lacked clinically relevant data necessary to adjust for the effects of comorbid conditions and disease severity on invasive cardiac procedure use.

Previous studies using administrative data bases have at least two other limitations, as well: 1) They failed to account for patients who may have been admitted to the hospital exclusively for the purpose of undergoing cardiac procedures. To the extent that white patients in these cohorts may have had a higher proportion of elective cardiac admissions, observed rates of inpatient cardiac procedures may have been biased toward higher utilization among whites (3–12). 2) Previous research has focused on either patient groups with a single cardiac diagnosis (e.g., acute myocardial infarction) (3) or heterogeneous diagnoses that include noncardiac diseases (e.g., aortic aneurysm) (4). These extremes in disease criteria

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Abbreviations and Acronyms

CABG = coronary artery bypass graft surgery
CC = cardiac catheterization
CVD = cardiovascular disease
DVA = Department of Veterans Affairs
IHD = ischemic heart disease
OR = odds ratio
PTCA = percutaneous transluminal coronary angioplasty
PTF = patient treatment file
RMRS = Regenstrief Medical Record System
VAMC = Veterans Affairs Medical Center

may have been too restrictive or too generalized to encompass the true clinical spectrum of IHD.

We sought to determine whether racial variation was present at our institution with regard to the use of CC, PTCA and CABG and to determine whether these treatment differences impacted on survival by replicating the methods of previous research within the DVA (4). In addition, we sought to extend research in this area by performing a pilot study to investigate the role of 1) critical clinical factors unavailable in administrative data bases; and 2) cohort selection criteria that would control for a) referred admissions and b) specified IHD diagnoses.

Methods

Study sites. This study was conducted at the Roudebush Veterans Affairs Medical Center (VAMC), a 400-bed, medical-surgical hospital that provides both primary and tertiary care. At the time of this study, this institution provided care to ~6,600 veterans in the outpatient clinics and emergency room per year, with ~7,600 patients discharged from the hospital annually. In addition to the DVA's inpatient administrative data base—Patient Treatment File (PTF)—the Roudebush VAMC uses a locally developed MUMPS-based version of the Regenstrief Medical Record System (RMRS) (13). The RMRS stores longitudinal data from the outpatient, emergency room and inpatient settings, including health services utilization, medication histories, clinical outcomes, results of tests and procedures and diagnoses made in the outpatient or inpatient setting (14). The study protocol was approved by the institutional review board at the Indiana University Medical Center, Indianapolis and the Roudebush VAMC.

Patient eligibility and identification. The CVD cohort consisted of inpatients, identified by computerized audit, who were discharged from the hospital between January 1 and December 31, 1993 with a primary diagnosis of CVD or chest pain (ICD-9-CM discharge codes 390-459 and 786.5-786.59 respectively; see Appendix). Eligibility criteria from a previous investigation (4) within the DVA were applied: male gender and age >30 years. Patients were excluded if they were ineligible for DVA care or received an invasive cardiac procedure within 90 days before index hospital admission, or if race was coded as other than African American or white. For all patients, the index event was defined as the first hospital admission for one of the target conditions during the study period.

Measures. Our primary dependent variable, invasive cardiac procedure use within prespecified periods after the index event (60 days for CC and PTCA, 90 days for CABG), was identified by computerized audit. For each relevant ICD-9-CM procedure code (see Appendix), we recorded the occurrence and date of each CC, PTCA and CABG. We then determined utilization for each invasive cardiac procedure category (individual patients could have contributed only once to each procedure category), as well as utilization of any cardiac procedure (individual patients could have contributed only once to any procedure category) during the specified periods.

Independent variables were assessed using three sources. Computerized audits of the PTF were used to obtain patient age, race, gender, marital status, entitlement status (a variable derived from the patient's service-connection status, which can affect access to outpatient care) and county of residence. Audits of the RMRS were used to identify conditions present before and during the index hospital admission that might make aggressive management of coronary artery disease less likely (see Appendix) (4). The RMRS was also used to supplement these data by determining whether additional comorbid diagnoses were present (e.g., stroke and congestive heart failure) and by obtaining measures of disease severity (e.g., laboratory assessments of renal and hepatic function, echocardiographic assessments, spirometry assessments) unavailable in the administrative data base. Finally, manual chart audits were used to collect additional clinical data that were unavailable in RMRS and PTF but were specified, a priori, as factors that might influence the management of coronary artery disease. These variables included initial therapies (including use of thrombolytic agents, intravenous nitroglycerin and intravenous heparin), patient refusal of recommended therapies and follow-up plans for those patients discharged from the hospital before performance of procedures. Chart audits were performed by senior medical students who had no knowledge of the study objectives and who demonstrated >90% agreement after baseline training and throughout the audit process.

Our secondary dependent variable, survival, was determined for two periods after the index hospital admission date—30 days and 1 year. Survival data were obtained through the Beneficiary Identification and Record Locator System.

Statistical analysis. To examine factors associated with invasive cardiac procedure use, we used *t* tests for continuous variables and either the Fisher exact test or the chi-square test for categoric data. These general approaches were applied to three patient cohorts (Fig. 1). To determine whether racial variation existed among inpatients at our VAMC, we formed the *CVD cohort* using ICD-9-CM discharge codes that were identical to a previously published investigation within the DVA (4). Two additional cohorts were subsequently formed to examine potential bases for observed racial variation: 1) Be-

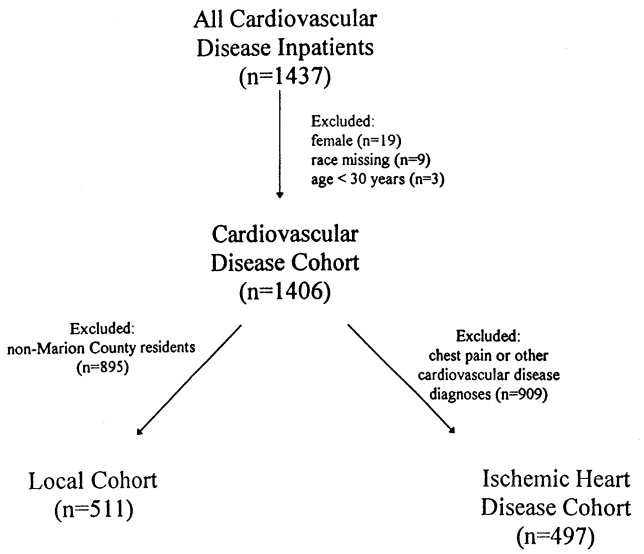

Figure 1. CVD cohort and refined cohorts.

Table 1. Demographic Characteristics of Cardiovascular Disease Cohort and Refined Cohorts

	CVD Cohort (n = 1,406)	Local Cohort (n = 511)	IHD Cohort (n = 497)
Mean age (yr)	63.4	61.8	57.4
Married (%)	58	50	64
Race (%African American)	15	33	8
Eligibility status (%)			
Service connected	16	25	30
Non-service connected	32	48	54
Primary diagnosis (%)			
Acute MI	8	7	21
Unstable angina	5	4	13
Angina	1	1	2
Chronic ischemia	22	16	64
Chest pain	9	11	0
Other diagnoses	56	60	0

CVD = cardiovascular disease; IHD = ischemic heart disease; MI = myocardial infarction.

cause the Roudebush VAMC is a tertiary medical center, many patients undergo elective cardiac procedures at this facility while receiving their primary and acute care elsewhere. Thus, the *local cohort* represented veterans who resided in Marion County (Indianapolis). 2) Because the CVD cohort included ICD-9-CM discharge codes that may not reflect IHD, the *IHD cohort* used restricted discharge codes to identify patients with a narrower spectrum of diagnoses (i.e., acute myocardial infarction [410-410.92], unstable angina [411-411.89], angina [413-413.9] or chronic ischemia [414.0, 414.8, 414.9]).

We used the Fisher exact test to compare 30-day and 1-year survival between African Americans and whites in the CVD cohort.

Results

Study cohorts. We identified 1,437 veterans who were admitted with CVD diagnoses, 1,406 of whom (98%) remained eligible for the CVD cohort. Computerized audits (PTF and RMRS) were conducted for all patients. Chart audits were performed in 1,043 of eligible patients (74%). Reasons for not performing a chart audit were that 311 charts (22%) could not be obtained from referral medical centers and 52 local charts (4%) could not be located after three requests. The refined cohorts contained 511 inpatients whose primary residence allowed inclusion in the local cohort and 497 inpatients whose primary diagnoses allowed inclusion in the IHD cohort.

The demographic characteristics of the patients in our cohorts are shown in Table 1. African Americans comprised 15% of the CVD cohort, 33% of the local cohort and 8% of the IHD cohort.

Invasive cardiac procedure use. *Cardiovascular disease cohort.* As in previous studies, the unadjusted analyses revealed that African Americans were less likely than whites to have CC performed during or within 60 days of the index hospital admission (odds ratio [OR] 0.37), CABG within 90 days of the index hospital admission (OR 0.22) or any cardiac procedure within the specified interval (OR 0.32) (Table 2). There was no statistical difference in the use of PTCA (OR 0.60) within 60 days of the index hospital admission.

Demographic and clinical variables associated with procedure use. Demographically, patients who received cardiac procedures were significantly younger and more likely to be married, be non-service connected for DVA care and reside outside of Marion County than those who did not receive procedures (Table 3). Clinically, patients were more likely to receive invasive cardiac procedures if they had not previously received CABG; did not have comorbid diagnoses of congestive heart failure, cerebrovascular disease, renal disease, ascites, diabetes mellitus or malignancy; were discharged from the hospital (index admission) with plans to later receive invasive cardiac procedures; and had lower disease severity, as measured by chest X-ray film criteria, serum blood urea nitrogen and creatinine, 24-h creatinine clearance estimates, serum albumin, pulmonary function testing and ideal body weight (Table 3). Because of the small number of African American patients receiving cardiac procedures, multivariate analyses controlling for race and clinical variables could not be performed. However, comparison of these clinical variables by race is described next.

Demographic and clinical variable comparisons between African Americans and whites are shown in Table 4. Demographically, African Americans were less likely than whites to be married, be non-service connected for DVA care and reside outside Marion County. Clinically, African Americans were more likely to have diagnoses of lung cancer, schizophrenia, dementia, renal disease and diabetes mellitus. African Americans also had higher disease severity, as measured by serum blood urea nitrogen and creatinine, estimated creatinine clearance, serum albumin, pulmonary function testing and ideal body weight.

Table 2. Unadjusted Procedure Rates for Cardiovascular Disease Cohort and Refined Cohorts

	CVD Cohort (n = 1,406)				Local Cohort (n = 511)				IHD Cohort (n = 497)			
	AA (n = 211)	W (n = 1,195)	OR	95% CI	AA (n = 169)	W (n = 342)	OR	95% CI	AA (n = 40)	W (n = 457)	OR	95%
CC	11%	25%	0.37*	0.24–0.58	11%	21%	0.47*	0.27–0.79	39	48	0.70	0.36–1.37
PTCA	2%	4%	0.60	0.25–1.49	3%	3%	1.11	0.38–3.20	13	10	1.36	0.52–3.53
CABG	1%	6%	0.22*	0.08–0.63	1%	4%	0.30	0.07–1.19	8	16	0.45	0.14–1.42
Any	11%	28%	0.32*	0.21–0.50	12%	22%	0.46*	0.27–0.78	42	57	0.55	0.28–1.06

*$p < 0.01$. AA = African American; CABG = coronary artery bypass graft surgery; CC = cardiac catheterization; CI = confidence interval; CVD = cerebrovascular disease; IHD = ischemic heart disease; OR = odds ratio; PTCA = percutaneous transluminal coronary angioplasty; W = white.

Refined cohorts. Among the 511 patients in the local cohort, the unadjusted OR of undergoing CC, PTCA, CABG or any procedure was 0.47, 1.11, 0.30 and 0.46, respectively, for an African American compared with a white veteran (Table 2). Among the 497 patients in the IHD cohort: the unadjusted odds ratio for undergoing CC, PTCA, CABG or any procedure was 0.70, 1.36, 0.45 and 0.55, respectively for African Americans versus whites (Table 2).

Survival. Comparison of survival between African American and white patients in the CVD cohort revealed nearly equivalent 30-day and 1-year survival rates (95% vs. 96% [OR = 0.75] and 84% vs. 88% [OR 0.73], respectively) (Table 5). Comparison of survival rates among patients in the additional cohorts revealed similar results (data not shown).

Discussion

Although we confirmed previously observed interracial differences in the use of invasive cardiac procedures among our nation's veterans (3,4), we extended the research by examining issues not previously explored:

1. We studied demographic and clinical factors associated with procedure use among patients in our cohort. We found that patients who received invasive cardiac procedures were more likely to be younger, married, and non-service connected for DVA care than those who did not receive procedures. These demographic differences have been observed by other researchers, and when controlled for in multivariate analyses, racial differences persisted. More importantly, when using the clinical data base, we found that patients who received procedures had fewer prespecified comorbid conditions and had lower noncardiac disease severity measures. We speculate that the presence and severity of these comorbid conditions may have had an impact on physicians' clinical decision-making regarding use of invasive cardiac procedures, because aggressive medical care is often restricted to those without concurrent severe or life-threatening comorbid conditions. When we studied these same factors in terms of race, African Americans were *less* likely to have clinical attributes associated with procedure use. However, because of the small sample size of African Americans receiving procedures in our cohort, we could not perform the necessary multivariate analyses to control for race and these clinical factors.

2. Previous studies have not adjusted for the effect of patient referral on the use of invasive cardiac procedures. When examining demographic factors among patients in the CVD cohort, we found that patients residing outside of Marion County were more likely to receive cardiac procedures and that African American patients were less likely to reside outside Marion County. This association was supported in the following additional analyses. We found that restricting our cohort to include only patients who received their primary care at this institution (local cohort) partially mitigated the observed racial differences between CC and CABG use while reversing the racial difference in PTCA use. A plausible explanation for this finding may be that rural Indiana populations, which are predominantly white, sought local medical care for early and acute symptoms of cardiac disease, and only after preliminary evaluation at these sites suggested severe cardiac disease were they referred for more invasive procedures. Thus, whites from these areas who were judged to have less severe cardiac disease and who were not referred to receive invasive cardiac procedures at this institution were not eligible for study inclusion. Therefore, previous studies that have examined inpatients at tertiary medical centers may have been similarly influenced by selecting patient groups with differing racial patterns for primary and referred medical care.

3. Refining our analyses to only patients with specified IHD diagnoses (IHD cohort) reduced racial differences for CC and CABG and reversed the racial difference for PTCA. Two factors may explain these findings: a) By limiting eligible diagnoses to IHD, we may have eliminated the influence of confounding conditions that also predispose patients to receive invasive cardiac procedures. For example, patients being considered for noncardiac operations often undergo extensive preoperative evaluation before elective operation. Given the broad nature of these predisposing diagnoses, such as peripheral vascular disease and cerebrovascular disease, the interpretation of invasive cardiac procedure use among these patients may be misleading. In our CVD cohort, patients included within the category of "other cardiovascular diseases" were numerous, had heterogeneous diagnoses and accounted for much of the variation in treatment between African Americans and whites. b) The observed reversal in PTCA use may be explained by recent research that has documented differences

between African Americans and whites with regard to findings during coronary angiography (15). This study found that African Americans had less severe coronary artery occlusion and a lower incidence of three-vessel disease than whites. Thus, African Americans were considered less often for revascularization procedures overall, and when considered for revascularization, they were more likely than whites to undergo PTCA but less likely to undergo CABG. Although we did not investigate coronary angiographic results among our IHD cohort, these previous findings suggest that local medical decisions that were based on detailed anatomic information may have led to appropriate racial differences in revascularization procedure use.

4. When examining survival at 30 days and 1 year after index hospital admission, we found that African Americans and whites had nearly equivalent survival rates. Thus, observed treatment differences did not translate into clinically significant poorer survival among African Americans in this cohort (a sample size of 4,800 patients would have been required to detect a statistically significant difference in these survival rates at a 0.05 significance level and 80% power). A similar observation has been previously reported among veterans admitted

Table 3. Demographic and Clinical Variables Among the Roudebush Cardiovascular Disease Cohort by Procedure Use

	Procedure (n = 362)	No Procedure (n = 1,044)	p Value
Demographic variables			
Mean age (yr)	61.6	64.5	<0.01
Married (%)	65	56	<0.01
Eligibility (%)			
Nonservice	55	48	<0.01
Service	27	25	
Marion County residence (%)	27	40	<0.01
Clinical variables			
Previous amputation (%)	1	1	1
Previous CABG (%)	8	12	0.02
CHF (%)	19	31	<0.01
Cerebrovascular disease (%)	6	10	<0.01
Lung cancer (%)	1	2	0.06
Schizophrenia (%)	2	4	0.06
Dementia (%)	1	2	0.13
Renal disease (%)	14	35	<0.01
Ascites (%)	0	2	<0.01
Diabetes (%)	24	39	<0.01
Any malignancy (%)	5	9	<0.01
Plans for later CC (%)	3	1	<0.01
Plans for later PTCA (%)	1	1	0.04
Plans for later CABG (%)	6	1	<0.01
Plans for later stress test (%)	6	4	0.09
Refusal of ER treatment (%)	1	1	0.52
Refusal of inpatient treatment (%)	8	11	0.27
CHF per chest X-ray film (%)	15 (n = 362)	23 (n = 1,044)	<0.01
COPD per chest X-ray film (%)	1 (n = 362)	3 (n = 1,044)	<0.04
BUN (mmol/liter)	6.4 (n = 222)	7.5 (n = 872)	<0.01
Creatinine clearance (ml/s)	1.3 (n = 224)	1.1 (n = 875)	<0.01
Serum creatinine (μmol/liter)	107 (n = 224)	122 (n = 875)	0.04
Serum albumin (g/liter)	40 (n = 195)	38 (n = 790)	<0.01
Fractional shortening by echocardiogram	0.24 (n = 96)	0.23 (n = 366)	0.15
Left ventricular diameter (cm)	5.1 (n = 107)	5.3 (n = 400)	0.13
FEV_1 (% predicted)	73 (n = 50)	67 (n = 233)	0.03
FVC (% predicted)	83 (n = 54)	78 (n = 256)	0.05
Weight (kg)	90.5 (n = 171)	87.7 (n = 622)	0.08
Ideal body weight (%)	116 (n = 171)	112 (n = 622)	0.03

Boldface indicates significant variables. BUN = blood urea nitrogen; CHF = congestive heart failure; COPD = chronic obstructive lung disease; ER = emergency room; FEV_1 = force expiratory volume in 1 s; FVC = forced vital capacity; LV = left ventricular; n = number of patients with a measurement obtained; other abbreviations as in Table 2.

Table 4. Demographic and Clinical Variables Among the Roudebush Cardiovascular Disease Cohort by Race

	African American (n = 204)	White (n = 1,202)	p Value
Demographic variables			
Mean age (yr)	63.3	63.9	0.51
Married (%)	44	61	<0.01
Eligibility			
Nonservice (%)	36	48	<0.01
Service (%)	20	22	
Marion County residence (%)	84	29	<0.01
Clinical variables			
Previous amputation (%)	1	1	0.27
Previous CABG (%)	8	11	0.23
CHF (%)	32	27	0.15
Cerebrovascular disease (%)	12	9	0.11
Lung cancer (%)	5	1	<0.01
Schizophrenia (%)	7	3	<0.01
Dementia (%)	3	1	0.02
Renal disease (%)	49	26	<0.01
Ascites (%)	3	2	0.14
Diabetes (%)	44	34	<0.01
Any malignancy (%)	11	7	0.09
Plans for later CC (%)	1	1	1
Plans for later PTCA (%)	0	1	1
Plans for later CABG (%)	1	2	0.33
Plans for later stress test (%)	4	4	1
Refusal of ER treatment (%)	2	1	0.20
Refusal of inpatient treatment (%)	10	10	1
CHF per chest X-ray film (%)	22 (n = 204)	21 (n = 1202)	0.64
COPD per chest X-ray film (%)	3 (n = 204)	3 (n = 1202)	0.71
BUN (mmol/liter)	8.9 (n = 177)	7.1 (n = 917)	<0.01
Creatinine clearance (ml/s)	1.0 (n = 177)	1.2 (n = 922)	<0.01
Serum creatinine (μmol/liter)	206 (n = 177)	107 (n = 922)	<0.01
Serum albumin (g/liter)	37 (n = 161)	39 (n = 824)	<0.01
Fractional shortening by echocardiogram	0.24 (n = 74)	0.23 (n = 388)	0.50
LV diameter (cm)	5.22 (n = 80)	5.24 (n = 427)	0.87
FEV_1 (% predicted)	63 (n = 38)	68 (n = 245)	0.13
FVC (% predicted)	69 (n = 42)	80 (n = 268)	<0.01
Weight (kg)	84.5 (n = 128)	88.6 (n = 665)	0.04
Ideal body weight (%)	109 (n = 128)	114 (n = 665)	0.05

Boldface indicates significant variables. Abbreviations as in Tables 2 and 3.

Table 5. Unadjusted Survival Rates for Cardiovascular Disease Cohort

	African American	White	OR	95% CI
30-day survival	95%	96%	0.75	0.37–1.51
1-year survival	84%	88%	0.73	0.48–1.09

CI = confidence interval; OR = odds ratio.

for care of an acute myocardial infarction (3). Taken together, these results serve to remind us that we must not rely on process of care measures as surrogates for quality of care measures.

Study limitations. Our study has important limitations: 1) Our sample size precluded us from performing anticipated multivariate analyses. Therefore, our reported racial differences in invasive cardiac procedure use and the observed effects of cohort modification are unadjusted for clinically relevant demographic and clinical variables. We can only speculate at this time whether the observed clinical differences had any legitimate impact on cardiac procedure use. 2) Even with the expanded clinical data available through the RMRS and chart audits, our retrospective design limited the completeness and accuracy of all potential data elements. We were unable to ascertain patient preferences for cardiac care, could not determine cardiac disease symptom severity and could not assess directly physicians' clinical decision-making factors with regard to invasive cardiac procedure recommendations. Undetected inaccuracies or misclassifications of recorded data likely reduced our ability to detect additional clinical differences, even if truly present. 3) Our data originate from one DVA institution, which limits the generalizability of our findings. Veterans have been shown to be sociodemographically different from other patient populations; therefore, extrapolation of these findings to other settings should be done with caution, particularly in settings that provide care to women. However, our overall results do appear to be strikingly similar to previous studies within the DVA, which suggests that our institution is not significantly different from others within this health care system.

Conclusions. Although invasive cardiac procedure use was significantly lower among African Americans than among their white counterparts, these treatment differences did not lead to clinically significant differences in survival. Our data suggest that potential explanatory factors for treatment disparity include the presence of more severe comorbid disease among African Americans and limitations of study designs that have not controlled for referral status and specified cardiac diagnoses. These findings provide hypotheses that must be tested in future investigations. These studies should use prospective, multisite designs that account for the patients' preferences for care, referral patterns and cardiac and noncardiac disease severity, which specifically address the appropriateness of invasive cardiac procedure use.

Appendix

Definition of Discharge Diagnoses and Dependent and Independent Variables (by International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] code)

Definition of Discharge Diagnoses

Rheumatic fever (390–392), rheumatic heart disease (393–398), hypertensive disease (401–405), ischemic heart disease (410–414), pulmonary circulation (415–417), other heart disease (420–429), cerebrovascular disease (430–438), disease of circulatory system (440–459), chest pain (786.5–786.59).

Definition of Variables

Dependent variables (by ICD-9-CM procedure code)

Cardiac catheterization: 37.21–37.23, 88.55–88.57; percutaneous transluminal coronary angioplasty: 36.00–36.03, 36.05–36.09; coronary artery bypass graft surgery: 36.10–36.19.

Independent variables

Comorbid diagnoses that may affect coronary artery disease management, such as human immunodeficiency virus disease; cancer, except nonmelanoma skin cancer; end-stage renal disease; cirrhosis; dementia; psychiatric illness; alcohol and drug abuse, excluding tobacco; chronic lung disease; stroke; peripheral vascular disease; and congestive heart failure.

Marital status was categorized as divorced, married, never married, separated, widowed or unknown.

Entitlement status was categorized as category A service connected, category A non-service connected or other.

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